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DETERIORATION OF CHRISTMAS HOLLY IN TRANSIT AND STORAGE

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INTRODUCTION

Although holly for Christmas decoration is shipped in large quantities from a number of points in the United States, the industry is chiefly centered along the Eastern Shore of Maryland and Delaware and the coastal area of North Carolina. While only a limited quantity is shipped from the Pacific Northwest, the industry there is increasing each year. The holly shipped from the East is known as American or wild holly (*Ilex opaca*), and that from the Northwest, largely grown under cultivation, is known as English or European holly (*I. aquifolium*). The foliage of the latter, which bears more numerous and much larger berries, is considered much more attractive than that of the native wild holly.

Christmas holly is distributed by freight or express from eastern shipping points to destinations as far west as Colorado and the Dakotas. In the shipping area centering along the coast of Delaware and Maryland the holly is mostly made up into wreaths. Districts farther south supply mostly branch holly. Both wreaths and branch holly are shipped from the Pacific Northwest.

PREPARATION FOR MARKET

In the East the material is gathered in near-by woods and the wreaths made in the homes. Sprays of three to six leaves are wired upon hoop frames of young, pliant growth such as maple, oak, or grapevine. The standard or common-sized wreath, known to the trade as the 10-inch wreath, is made on a hoop measuring from 9 to

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10 inches in diameter. After the leaf sprays are fastened in position, four clusters of either natural or artificial berries are wired on each wreath. Certain markets demand wreaths with natural berries. The use of artificial berries, however, is said to be growing because of the increasing scarcity of natural berries and because of their tendency to shatter off in handling. The sprays for making wreaths are broken from all sizes of trees; those of richer color and larger leaves come from trees growing in the low swamp lands.

The finished wreaths are either bought at the homes of the makers by agents of the shippers and by jobbing buyers or brought to the railroad shipping points and sold direct to shippers.

For shipping, the usual practice is to pack the wreaths in cases 2 by 2 by 4 feet made of quarter-inch-thick lumber and lined with newspaper. A few shippers use paper cartons of various sizes. In filling these cartons the wreaths are packed without any definite arrangement. The usual number of wreaths to the case is 17 dozen, although this means packing them rather tightly. Each case weighs from 110 to 125 pounds. Wreaths with natural berries are packed separately from those with artificial berries, otherwise little or no effort is expended in grading.

Branch holly consists of branches with both leaves and berries. It is usually packed loosely without any definite arrangement, in cases similar to those used for wreaths.

The shipping season for Christmas holly begins about November 20 for the most distant points to which shipments are made by freight. Express shipments begin about December 1, the last shipments leaving about December 20 for near-by points. Freight shipments move in solid car lots, in box cars of steel or wood that hold about 166 cases and are usually lined with building paper. Refrigerator cars are seldom used. Express shipments usually consist of small lots that may be collected into car lots or may move in cars loaded with other express.

DISCUSSION OF PROBABLE CAUSE OF INJURY

During the last few years frequent complaints have been made by receivers of Christmas holly relative to the condition on arrival of wreaths and, to a limited extent, of branch holly. Instead of arriving in the desired fresh green condition, the leaves are found to present an unattractive bronze-green color ranging through shades of brown to almost black, and in the latter condition the leaves detach easily and shatter off. Plate 1 illustrates a wreath with both discolored and normal leaves. Receivers frequently attribute this discoloration to freezing injury in transit.

To determine definitely the cause of this discoloration and to find ways of preventing it, investigations were begun in 1928 and continued through the shipping season of 1930. Many of the larger shippers in Delaware, Maryland, and North Carolina were interviewed. Methods of making and packing wreaths were observed. Equipment and methods used by the carriers in handling holly were studied, and shipments were carefully examined, both at the points of origin and at destinations.



A. Hoen & Co., Inc.

Holly wreath showing typical discoloration of leaves, due to relatively high temperature in storage

(Photograph colored by Mary D. Arnold)



Although opinion differed widely as to the cause of the browning or discoloration, practically all the shippers interviewed were of the opinion that holly is not injured nor discolored by freezing. Many expressed the belief that freezing either before or after cutting produces a permanently darker and more attractive green in the leaves. Very often holly sprays are gathered from the trees while frozen and made up into wreaths, which often remain frozen until delivered to the shippers.

The freezing-point determinations by the writers show that holly leaves freeze at an average temperature of 26.3° F. The air temperature at the shipping season is frequently much lower. Some shippers stated that complaints on the condition on arrival at the markets do not as a rule follow shipments during freezing weather.

It was the opinion of a majority of those interviewed that complaints were more likely to follow warm, humid, or "muggy" weather during the shipping season, and for this reason most of them preferred freezing weather for packing and shipping. A number of the shippers found that during comparatively warm weather damage might occur if wreaths were packed and the cases closed and allowed to stand before shipping. Under such temperature conditions these men make a practice of not nailing down the lids on the packed cases until they are ready to ship, thus securing maximum air circulation in the interior of the cases. Two shippers said they had taken substantial losses by closing up cases of wreaths and allowing them to remain in their packing rooms for several days during warm weather. On examination they found the contents of the cases had heated and were seriously discolored.

A study of daily temperature records, made during the shipping seasons of 1928 and 1929 by one cooperative observer of the United States Weather Bureau within an area from which much of the Delaware holly is shipped, showed that in 1928 between December 12 and 19 the daily maximum temperatures ranged from 51° to 63° F., and in 1929 a period of high temperatures between December 14 and 20 had a range of maximum temperatures from 61° to 70°. In connection with this study it is interesting to note that an investigation of a number of complaints of alleged transit freezing damage to shipments originating in this general vicinity showed practically all these shipments to have been made during periods of comparatively high temperatures.

SHIPPING AND STORAGE INVESTIGATIONS

A series of experiments under controlled conditions was carried on during 1928, 1929, and 1930 to determine the causes of discoloration in holly.

SEASON OF 1928-29

During the 1928-29 shipping season the experiments were more or less preliminary, and comparatively small unit lots were used in these studies. Loose sprays, or small branches similar to those used in wreath making, were rather closely packed in 4-quart veneer baskets such as are commonly used as containers for certain fruits.

These baskets were then wrapped in paper to restrict the air circulation to correspond as nearly as possible to the conditions in the usual tightly packed, paper-lined holly shipping case.

EXPERIMENT 1

A large quantity of freshly gathered holly was obtained December 5, 1928, at a point in Delaware, packed fairly tight in ordinary bushel baskets lined with newspaper, and expressed directly to the laboratory in Washington, D. C. On arrival early the following day the foliage appeared as fresh and green as when gathered.

Several small units were put up in 4-quart baskets and wrapped as previously described. One lot of five baskets was lightly sprinkled with water before wrapping, and five other baskets, to which no water was applied, were used as checks. A basket of the sprinkled holly and one of the dry pack were then put in storage at each of the following temperatures: 32°, 40°, 50°, 60°, and 70° F., with relatively high humidities.

Five additional baskets of holly that had not been wet were put in storage at 0° for 24 hours. At the end of this period the leaves were found to be frozen quite stiff and showed a whitish mottled appearance, which disappeared when the leaves thawed. These baskets were removed after 24 hours and stored with the unfrozen lots at the temperatures described.

Cursory examinations of these test lots were made from day to day, but no sufficiently significant changes to justify a complete inspection were noted until the seventh day. The results of inspections made at all the storage temperatures after 7 and 11 days from the beginning of the experiment are shown in Table 1.

TABLE 1.—Condition of frozen and unfrozen dry holly and unfrozen wet holly after storage for 7 and 11 days at various temperatures. (Experiment 1, 1928-29)

Storage temperature	Frozen, dry, at 0° F. for 24 hours		Unfrozen, dry		Unfrozen, wet	
	Condition after 7 days	Condition after 11 days	Condition after 7 days	Condition after 11 days	Condition after 7 days	Condition after 11 days
° F.						
32	Excellent.....	Excellent.....	Excellent.....	Excellent.....	Excellent.....	Excellent.
40do.....do.....do.....do.....do.....	Do.
50	Some discoloration.	Some discoloration.	Some discoloration.	Increased discoloration.	Considerable discoloration.	Badly discolored; unsalable.
60	Mostly unsalable.	Unsalable.....	Mostly unsalable.	Unsalable.....	Badly discolored; unsalable.	Do.
70	Badly discolored; unsalable.	Badly discolored; unsalable.	Badly discolored; unsalable.	Badly discolored; unsalable.do.....	Do.

EXPERIMENT 2

On December 26, 1928, a similar but smaller quantity of holly than was used in experiment 1 was packed and shipped from the same general locality, reaching Washington on December 27. It was divided and stored as before except that only one basket lot was

frozen. This was frozen at 0° F. for 48 instead of 24 hours and was subsequently stored at 70°. Results are given in Table 2.

TABLE 2.—Condition of frozen and unfrozen dry holly and unfrozen wet holly after storage for 6 and 9 days at various temperatures. (Experiment 2, 1928–29)

Storage temperature	Frozen, dry, at 0° F. for 48 hours		Unfrozen, dry		Unfrozen, wet	
	Condition after 6 days	Condition after 9 days	Condition after 6 days	Condition after 9 days	Condition after 6 days	Condition after 9 days
°F.						
32	-----	-----	Excellent	Excellent	Excellent	Excellent.
40	-----	-----	do	do	do	Do.
50	-----	-----	Good; salable.	Some discoloration; salable.	Good; salable (brighter than dry stored lot).	Considerable discoloration; unsalable.
60	-----	-----	Some discoloration; salable.	Badly discolored; unsalable.	Considerable discoloration; unsalable.	Badly discolored; unsalable.
70	Badly discolored; unsalable.	Badly discolored; unsalable.	Badly discolored; unsalable.	do	Very badly discolored; unsalable.	Very badly discolored; unsalable.

EXPERIMENT 3

On January 28, 1929, two 1-bushel baskets of loose holly sprays were cut near Wilmington, N. C., and immediately taken into Wilmington. One basket was left in an unheated wareroom at a temperature of 45° to 50° F., and the other was put in a storage room at 10° below zero and left for 24 hours. The following day both baskets were expressed to Washington, D. C., arriving the next day in excellent condition. Immediately on arrival both baskets were divided, packed in small units as heretofore described, and the frozen and unfrozen lots were stored at the same temperatures as were previously used. The results are given in Table 3.

TABLE 3.—Condition of frozen and unfrozen holly shipped from Wilmington, N. C., to Washington, D. C., and stored for 8 and 11 days at various temperatures. (Experiment 3, 1928–29)

Storage temperature	Frozen		Unfrozen	
	Condition after 8 days	Condition after 11 days	Condition after 8 days	Condition after 11 days
°F.				
32	Excellent	Excellent	Excellent	Excellent.
40	do	do	do	Do.
50	Slight discoloration; salable.	Increased discoloration; salable.	Slight discoloration; salable.	Increased discoloration; salable.
60	do	Considerable discoloration; unsalable.	do	Considerable discoloration; unsalable.
70	Badly discolored; unsalable.	Badly discolored; unsalable.	Badly discolored; unsalable.	Badly discolored; unsalable.

EXPERIMENT 4

On January 30, 1929, at another point near Wilmington, N. C., enough exceptionally attractive holly, with large, glossy leaves and well supplied with berries, to fill two 1-bushel baskets, was cut and

immediately expressed to Washington, arriving the following day. One basket was placed in storage at 40° F., and the other was put at a temperature of 0° and left for 48 hours. After this period small unit lots of both frozen and unfrozen holly, similar to those already described, were put up and stored as in experiment 3. The results are given in Table 4.

TABLE 4.—*Condition of holly shipped from Wilmington, N. C., to Washington, D. C., and stored at various temperatures for 5 and 11 days. (Experiment 4, 1928-29)*

Storage temperature	Frozen at 0° F. for 48 hours		Unfrozen; held at approximately 40° F. before storage	
	Condition after 5 days	Condition after 11 days	Condition after 5 days	Condition after 11 days
° F.				
32	Excellent.....	Excellent.....	Excellent.....	Excellent.
40	do.....	do.....	do.....	Do.
50	Slightly discolored....	Moderately discolored; salable.	Slightly discolored....	Discolored; unsalable.
60	do.....	do.....	do.....	Do.
70	Discolored; unsalable...	Badly discolored; unsalable.	Discolored; unsalable..	Badly discolored; unsalable.

RESULTS OF 1928-29 EXPERIMENTS

In general, the results of the 1928-29 group of experiments showed that all lots of holly, whether frozen or unfrozen, stored at 32° and 40° F., remained as bright and fresh at the close of the experiments as when received. In the frozen and unfrozen lots held at the different temperatures, very little difference could be detected; however, the foliage of the frozen lots seemed to remain a little brighter and greener. Comparing wet and dry stored holly at temperatures above 40°, discoloration was more marked and developed more rapidly in the wet or sprinkled lots. The intensity of discoloration increased with the holding temperatures used.

SEASON OF 1929-30

EXPERIMENT 5

During the 1929-30 shipping season, storage tests were carried on with wreaths only. For the first experiment of this season (experiment 5) a case of holly wreaths of unusually good quality with natural berries and without any trace of discoloration was purchased at a point in Delaware on December 18, 1929, and immediately shipped to Washington, arriving on the following day. The case was opened, and representative lots of 20 wreaths each were then repacked into each of 10 paper-lined bushel baskets, with newspaper spread over the top of the wreaths and tucked in at the sides. It was necessary to press down the contents rather firmly in order to fasten the lids. It was thought that with the wreaths tightly packed and covered with paper the conditions in each basket unit would eventually approximate those in the regular case units.

Five of the baskets of holly were set aside at a temperature of 40° F., the other five being kept at a temperature of 0° for 25 hours.

At the end of this time the leaves of the latter were frozen quite stiff and the temperature at the center of the baskets averaged 16°, which is well below the freezing point of the leaves. A basket each of frozen and unfrozen holly was then put into storage at 32°, 40°, 50°, 60°, and 70° F. Periodic inspections were made and the number of discolored wreaths recorded, as shown in Table 5. The "slightly discolored" grade included those wreaths showing only a few slightly discolored or light-brown leaves; they would be classed as salable at a discount. The "discolored" grade included unsalable wreaths, with leaves of a solid brown to brownish black or spotted color.

TABLE 5.—*Discoloration found among frozen and unfrozen holly wreaths after storage for different periods at various temperatures. (Experiment 5, 1929-30)*

Storage period	Storage temperature	Frozen lots—			Unfrozen lots—		
		Not discolored	Slightly discolored	Discolored brown	Not discolored	Slightly discolored	Discolored brown
	° F	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
3 days-----	70	70	30	0	80	10	10
	60	75	25	0	55	15	30
	50	100	0	0	100	0	0
	40	100	0	0	100	0	0
	32	100	0	0	100	0	0
5 days-----	70	30	35	35	55	25	20
	60	55	45	0	35	35	30
	50	80	20	0	75	25	0
	40	100	0	0	100	0	0
	32	100	0	0	100	0	0
7 days-----	70	25	35	40	20	60	20
	60	50	30	20	35	25	40
	50	80	20	0	70	20	10
	40	80	20	0	70	30	0
	32	100	0	0	100	0	0
10 days-----	70	0	25	75	0	10	90
	60	25	35	40	5	50	45
	50	80	20	0	55	30	15
	40	80	20	0	60	40	0
	32	100	0	0	100	0	0

In both frozen and unfrozen lots the amount of discoloration diminished as the storage temperature was lowered. At 40° F. only slight discoloration developed after seven days of storage and did not increase materially after that time. The lots held at 32° looked as fresh and attractive at the close of the experiment as at the beginning. In the lots held at 60° and 70°, at the close of the experiment most of the leaves were dark brown to almost black and many of the leaves and berries shattered off when handled. No discoloration of berries that could properly be attributed to freezing or storage injury was noted. A considerable number of black or discolored berries were found when the case of wreaths was received, but careful examination showed in all instances that the injury was mechanical, being due to crushing and bruising while being packed.

EXPERIMENT 6

A storage and transportation test with holly wreaths in the usual commercial shipping cases was also conducted. On December 4,

1929, two freshly packed cases of wreaths showing no discoloration were obtained from a point in Delaware and held overnight in a near-by wareroom at approximately 40° F. The next morning one of the cases was put in a freezing room at a temperature ranging from 0° to -20°, and when removed the following morning the wreaths were stiffly frozen. Both the frozen and the unfrozen cases were then expressed to Washington and upon arrival the following morning (December 7) were put directly into storage at 40°. On December 11 the contents of these cases were inspected, and 10 per cent of the wreaths in the frozen lot were classed as mildly discolored, as against 2 per cent in the unfrozen lot.

The cases were then repacked as before and on December 12 were expressed to Chicago, where on December 14 they were again inspected, with the result that 21 per cent showed discoloration in the frozen lot and 13 per cent in the unfrozen lot. In addition, some condensation of moisture was found in the frozen lot, while none was apparent in the unfrozen lot; however, in the frozen lot the wreaths not discolored presented a brighter and more glossy appearance than those in the unfrozen lot.

SEASON OF 1930-31

EXPERIMENT 7

In view of the fact that in the foregoing experiments comparatively small lots of frozen holly showed less discoloration of the leaves than the unfrozen material, and that when using commercial case lots the frozen holly showed more discoloration, which seemed to be associated with a certain amount of condensation that was not found on unfrozen holly, it was decided to conduct another test with these larger lots during the shipping season of 1930-31.

Three freshly packed cases of 17 dozen good-quality wreaths with natural berries were obtained December 8, 1930, at a shipping point in Delaware and expressed to Washington, arriving the following morning.

In order to obtain more comparable samples of wreaths for each condition used in this test, the contents of all three cases were removed and the cases repacked with wreaths selected at random from the entire quantity. Case 1 was then placed in a storage room held at 50° F. with a relatively high humidity; case 2 at 29°; and case 3 at 17°. The latter temperature was well below the freezing point of holly but not so low as the freezing temperatures used in the preceding experiments. It was thought that perhaps the very low freezing temperatures previously employed were below those usually encountered in transit and therefore might have had a different effect from freezing at a higher temperature. To determine the rate of cooling and the time at which freezing commenced in case 3 stored at 17°, small electrothermocouples were placed among the wreaths near the bottom and near the end, at the center, at the top center, and near the end at the top. In each instance the entire thermocouple was wrapped in four leaves and the bundle tightly tied, so that the temperatures recorded could be considered as the actual temperatures of the leaves themselves. Frequent readings

were made to record the rate of cooling at the various locations and to determine when freezing commenced and the freezing point of the leaves.

The results obtained from the readings with thermocouples, as recorded in Figure 1, show that the rate of cooling was more rapid at the bottom near the end of the case and least rapid near the top center. Freezing in the former position began in about 4 hours and in the latter after about 15 hours. The average freezing point as de-

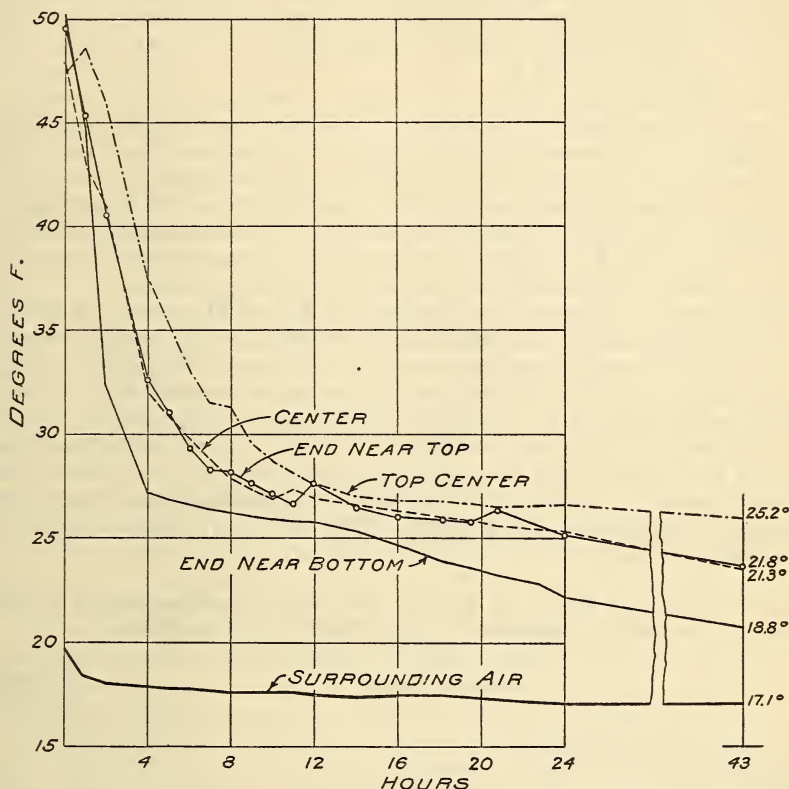


FIGURE 1.—Rate of cooling at various locations in a commercial shipping case of holly wreaths held at about 17° F.

termined was about 26.3° F. The beginning of freezing was taken as the time the temperature at a particular location became more or less stationary over a period of a few hours, before again starting to approach that of the storage room.

After 43 hours' storage, cases 2 and 3 were transferred from 29° and 17° F. storage, respectively, to 50°, at which temperature discoloration would normally be expected, and where case 1 had been continuously held.

Three days after the beginning of the experiment and one day after cases 2 and 3 had been transferred to 50° F., an inspection of case 1, held continuously at 50°, showed no discoloration and no condensation of moisture. Cases 2 and 3 were not disturbed except to raise the lids; slight condensation of moisture was visible in both.

Four days later a thorough inspection of all the cases was made. Case 1 had 45.5 per cent of the wreaths classed as discolored, and these showed only a slight to a medium amount of browning; none of them was termed "unsalable." Nearly all the wreaths that showed no browning were somewhat faded owing to the loss of much of the natural luster, and they appeared to be somewhat dry and brittle. Case 2 showed 15.7 per cent of the wreaths discolored, and those not browned were somewhat less faded than those in case 1. Case 3 had only 3.3 per cent of the wreaths classed as discolored. Most of those not discolored were still glossy and apparently in as good condition as when packed. Some condensation of moisture was still apparent in cases 2 and 3.

The following day case 1 was again examined, and it showed 65 per cent of the wreaths discolored, some very badly; the remainder was beginning to brown but not enough to be designated as discolored.

After two more days a final inspection on cases 2 and 3 showed 66.2 per cent of the wreaths discolored in the former and 72.6 per cent in the latter. In case 3 most of the wreaths not discolored were still rather glossy and presented, in general, a better appearance than those in case 2. No condensation was visible at this time.

After case 1 had been in storage at 50° F. for five days and cases 2 and 3 for three days, thermometers inserted to the center of each showed the internal temperatures as follows: Case 1, 54°; case 2, 53.4°; and case 3, 54.6°. Two days later case 1 showed 53.3°; case 2, 53.6°; and case 3, 55.4°. These temperatures are significant, in that they showed the internal temperatures of the cases to be higher than that of the surrounding air, owing probably to the accumulated heat of respiration. In case 3, where most discoloration was found, the internal temperature was highest. The results of these inspections are shown in Table 6.

TABLE 6.—*Effects of storage at different temperatures in discoloration of holly wreaths in commercial cases. (Experiment 7, 1930-31)*

Items of comparison	Percentage discolored
Case No. 1, stored continuously at 50° F.:	
After 3 days.....	0
After 7 days.....	45.5
After 8 days.....	65.0
Case No. 2, stored at 29° for 43 hours, then at 50° to end of test:	
After 43 hours at 29° and 1 day at 50°.....	(¹) 15.7
After 43 hours at 29° and 5 days at 50°.....	66.2
After 43 hours at 29° and 8 days at 50°.....	
Case No. 3, stored at 17° for 43 hours, then at 50° to end of test:	
After 43 hours at 17° and 1 day at 50°.....	(¹) 3.3
After 43 hours at 17° and 5 days at 50°.....	72.6
After 43 hours at 17° and 8 days at 50°.....	

¹ Contents not disturbed; slight condensation on top layer.

CONCLUSIONS AND RECOMMENDATIONS

When experimental lots of frozen and unfrozen branch holly or holly wreaths were stored at various temperatures, little or no discoloration developed at 32° or 40° F. At 50°, 60°, and 70° F., however, discoloration was found in both classes of material in increasing amounts as the storage temperature increased. In practically all instances more discoloration developed in the unfrozen than in the

frozen holly. When commercial shipping-case lots of frozen and unfrozen holly wreaths were used in transportation and storage tests, more discoloration was found in the frozen lots.

Analyzing the results of the various experiments, it seems conclusively proved that freezing of Christmas holly does not in itself cause discoloration in transit or storage. In most of the small-lot experiments the frozen holly leaves presented a better appearance because they retained the natural luster or gloss for a longer time than did the unfrozen holly. In experiments where stored lots of holly sprinkled with water were compared with lots stored dry, more discoloration of the leaves at temperatures of 50° F. or above was noted in the sprinkled lots.

The explanation of the greater amount of discoloration developing in the commercial-case lots of frozen holly is based on a generally familiar phenomenon. When any object is taken from a comparatively low temperature to a comparatively high one, where the air is sufficiently humid, condensation of moisture on the cold object will result. When a case of holly that has been frozen (the temperature going at least as low as the freezing point, which averaged around 26.3° F.) is subjected to a considerable rise in temperature, as is quite likely to occur during transportation, condensation throughout the contents, caused by the entering warmer air being cooled below the dew point, may be expected. The moisture resulting from condensation will also be augmented by natural transpiration. This accumulation of moisture is apparently responsible for the discoloration complained of, rather than the fact that the holly had been frozen. Temperatures low enough to cause actual freezing injury are not necessary to produce moisture condensation; under proper conditions a rapid transfer from a comparatively low to a relatively high temperature is sufficient. In examining commercial cases of wreaths as they arrived on certain markets, condensation was often noted when the cases were opened.

More complaints are made relative to discoloration in crates of wreaths than in those of branch holly. This may be attributed to the fact that branch holly in cases is not so compact, and any condensation disappears more rapidly, the total quantity of actively transpiring green leaves being much less. In the experiments with relatively small lots of holly the contents of the packages were not so compact, and the surrounding paper very likely absorbed moisture.

Cases containing thick, full-foliaged wreaths should not be packed in the same number as when the wreaths are thinner and lighter. A maximum of 15 dozen of such heavy wreaths is recommended. The cases then would not be so tightly packed and would be in less danger of heating.

Figure 2 suggests a method of packing wreaths. By this method the wreaths are packed in definite stacks, which, although overlapping somewhat, allow several air channels from top to bottom of the case. Better ventilation and, to a great extent, prevention of the normal accumulation of moisture due to transpiration, respiration, and condensation seem to be necessary requisites in successful handling. Cases packed in this orderly fashion will contain as many wreaths as the cases now in use and will be much more attractive in appearance.

Packers and shippers are advised not to have too many cases of wreaths packed up ahead of their shipping schedule during warm

"muggy" weather, since heating and discoloration are likely to occur in a few days unless the inside temperature of the cases is kept at least as low as 40° F.

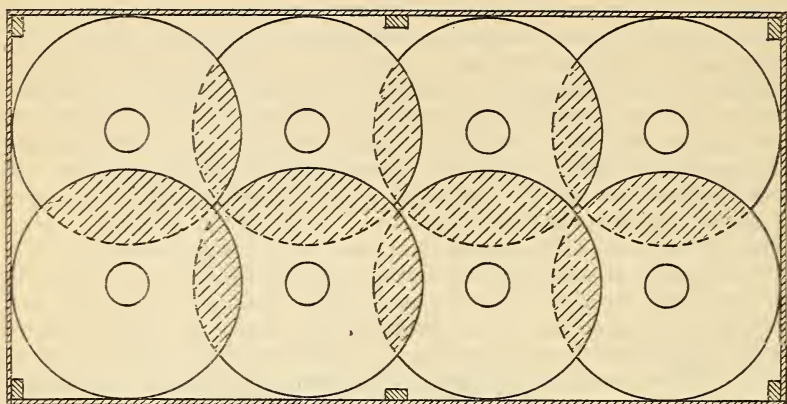


FIGURE 2.—A suggested system for packing holly wreaths in the usual size commercial shipping case

SUMMARY

Holly for Christmas decoration is shipped extensively from the coastal regions of Delaware, Maryland, and points south to North Carolina, and in limited quantities from the Pacific Northwest.

Frequent complaints are made that decorative holly arrives on the market in a brown to black discolored condition, which is attributed by the receivers to freezing in transit. More discoloration is complained of in holly wreaths than in loose holly.

Observations were made of methods of handling, shipping, and transportation from points in Delaware, Maryland, and North Carolina, and also of methods of handling in the markets.

Most packers and shippers who were interviewed think discoloration is due to heating after packing, and that freezing does not damage holly.

The average freezing point of holly leaves was determined as 26.3° F.

The experimental freezing of holly apparently did not directly cause brown discoloration of the leaves.

Holly when stored at temperatures of 50°, 60°, or 70° F. seemed to discolor proportionately as the temperature increased, but when stored at 32° or 40° little or no discoloration resulted.

Berries did not discolor except when mechanically injured.

Holly sprinkled with water before storing became more discolored at storage temperatures of 50° and above than holly stored dry at the same temperature.

Experimental commercial case lots of wreaths that had been frozen and then stored at 40° and 50° F. showed the presence of moisture due to condensation and developed more discoloration than unfrozen lots.

The internal temperatures of cases of holly stored at 50° F. were from 2 to 6 degrees higher than that of the surrounding air.

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